Space Weather Technical Forecast

Issued on Tuesday, 26 September 2023 at 13:03 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-flares (R1-R2 Radio blackouts) throughout. Slight chance of G1-G2/Minor to Moderate geomagnetic storms Day 1 (26 Sep).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low, with the largest flare a C5.7 at 26/0428UTC, originating from AR3445.

There are currently eight numbered and one un-numbered sunspot regions on the visible disc, with six of these located in the western hemisphere. AR3445 (Dai/Beta) in the south-centre disc is a mixed polarity region and remains the largest, most active. Only small changes in evolution have been observed in recent imagery. AR3435 (Dsi/Beta-Gamma) and AR3443 (Eso/Beta-Gamma) both remain moderately large bipolar regions, again with slow overall changes in evolution. Also, AR3443 is now beginning to rotate around the northwest horizon. AR3447 (Dao/Beta), now nearing south-centre, has continued to show some growth and consolidation. Other region are generally simple and unremarkable.

A filament lift-off around 25/1540 UTC produced a CME to the northwest which is being assessed for any potential Earth directed component. Otherwise, no other potential Earth-directed CMEs have been observed in the past 24hrs.

Solar Wind / Geomagnetic Activity: Solar winds have been at largely slightly elevated levels (420-480 km/s), with peak 513 km/s, due to the lingering effects of a CME which arrived at Earth on the UTC evening of the 24 September. Density started the period above average, with a peak of 37 ppcc at 25/1150UTC, before reducing to average levels after 25/2100UTC. The Interplanetary magnetic field strength (IMF), Bt, followed a similar trend, starting at strong levels, around 30nT, but at the time of writing near 10nT. The north-south component (Bz) was often at moderate levels, but switched from predominantly positive (northward) to predominantly negative (southward) after midnight UTC, in the range +15nT to -12nT. Phi angle was predominately positive (away from the Sun) but has recently switched to negative (toward the Sun) from around 26/1000UTC. Resultant geomagnetic activity was in the range Quiet to Active (Kp 2 to 4), but with a G1/Minor Storm (Kp 5) interval observed between 26/0600-0900UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was at mainly background levels. Associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold and on a declining trend. The observation at 25/0001 UTC was 1.11e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be generally Low, but with a chance of M-class flares, and a slight chance of isolated X-class flares, most likely from AR3445 in the south.

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Met Office Space Weather Technical Forecast

Solar Wind / Geomagnetic Activity: Further CME arrivals are possible into Day 1 (26 Sep). Confidence is low however, with glancing impacts most likely. Solar winds are likely to remain at slightly elevated levels on day 1 (26 Sep) gradually trending toward slow-ambient levels in the absence of any further CME arrivals. Geomagnetic activity will be mostly Quiet to Active (Kp 2-4), with a chance of G1/Minor Storm (Kp 5) intervals on Day 1 (26 Sep) due to ongoing waning CME effects, and also possible further glancing CME effects. Quiet to Unsettled (Kp 1-3) activity is then expected to dominate from Day 2 (27 Sep). However, a further enhancement is possible late on Day 3 (28 Sep) with another potential glancing CME, but this is very low confidence.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with a daily slight chance of an enhancement should any larger flares occur.

High energy electron flux (greater than 2MeV) continues at mostly background levels. Confidence reduces later in the period with a chance of returning to diurnally high by Days 3 and 4 (28-29 Sep). The associated 24 hour fluence is at background levels and is expected to remain below the Active threshold through the period.

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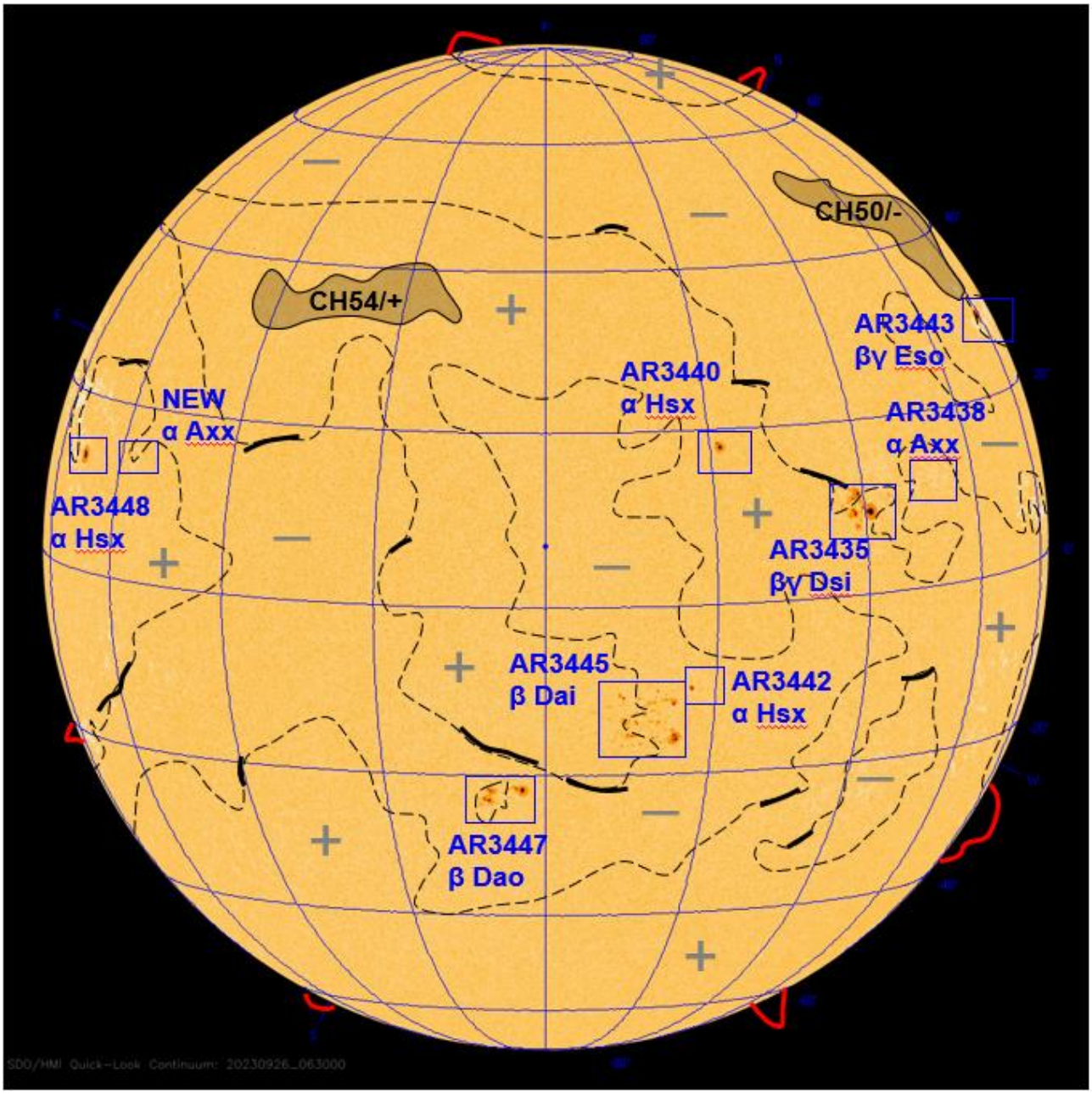
Figure 1. Solar Analysis Valid 26/0700 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The geomagnetic forecast is currently low confidence due to the number of CME's that have recently left the Sun. The CME associated with the long period M1.2 flare from 22/0336 UTC arrived late on the 24 Sep. This may have swept up and combined with other CMEs from 20 Sep and 21 Sep. The effects of the CME are continuing to wane.

There remains the potential for arrivals from two further CMEs from early on 22 Sep. The first from south of the AR3435/38 complex spot, and a further one to the north of this region. These are both weak eruptions but give a slight chance of further enhancements on Day 1 (26 Sep) but these are very low confidence. Other CMEs which feature in the forecast are from the double peak M1.5/1.4 flare at 22/1621 UTC and 22/1714 UTC of AR3443 in the northwest and from the M1.9 flare at 22/2300 UTC from AR3435/38. These CMEs are currently expected to be missing Earth but may give slight glancing impacts, potentially combined within the material in the aforementioned CMEs.

Further CMEs were observed leaving the Sun from the western limb on 24 Sep. Most appear to be far-sided, with a suggestion one could give a weak glancing blow late on Day 3 (Sep 28), although this is low confidence.

Overall this gives a reduced confidence in the geomagnetic forecast. Geomagnetic activity will be mostly Quiet to Active (Kp 2-4), with a chance of G1/Minor Storm (Kp 5) intervals on Day 1 (26 Sep) due to ongoing waning CME effects, and also possible further glancing CME effects. Quiet to Unsettled (Kp1-3) activity is then expected to dominate from Day 2 (27 Sep). However, a further enhancement is possible late on Day 3 (28 Sep) with another potential glancing CME, but this is very low confidence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	30	20	10	20
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
22/1134	Partial	Filament	NW	592 km/s	26 Sep	Missing/glancing
22/1504	Partial	Filament	SW	497 km/s	26 Sep	Missing/glancing

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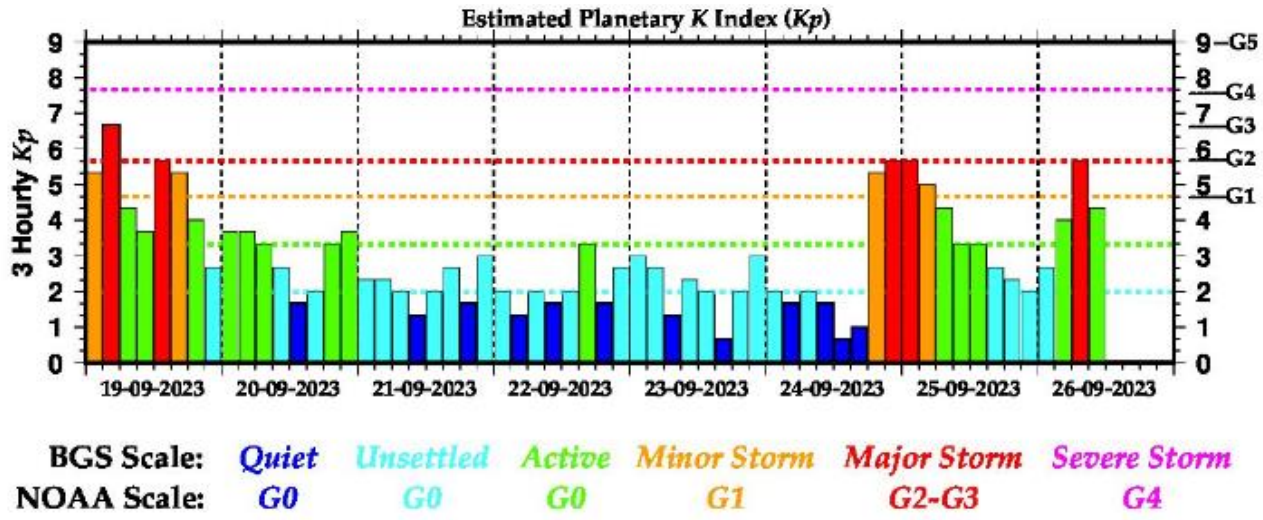
Figure 2: BGS plot of geomagnetic activity over the past 7 days.



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Radio Blackouts - X-Ray Flares:

Solar activity has been Low. The largest flare was a C5.7 flare at 26/0428UTC, originating from AR3445. There remains a chance of further M-flares, with a slight chance of an X-flare, most likely from AR3445.

There are currently eight numbered and one un-numbered sunspot regions on the visible disc, with six of these located in the western hemisphere. AR3445 (Dai/Beta) in the south-centre disc is a mixed polarity region and remains the largest, most active. Only small changes in evolution have been observed in recent imagery. AR3435 (Dsi/Beta-Gamma) and AR3443 (Eso/Beta-Gamma) both remain moderately large bipolar regions, again with slow overall changes in evolution. Also, AR3443 is now beginning to rotate around the northwest horizon. AR3447 (Dao/Beta), now nearing south-centre, has continued to show some growth and consolidation. Other region are generally simple and unremarkable.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is likely to persist at background levels, however there are regions either on, or moving across the western disc which bring a chance of flux levels rising above background given the occurrence of any significant flares. This includes AR3443 and AR3435, as well as AR3445 in the south.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	15	15	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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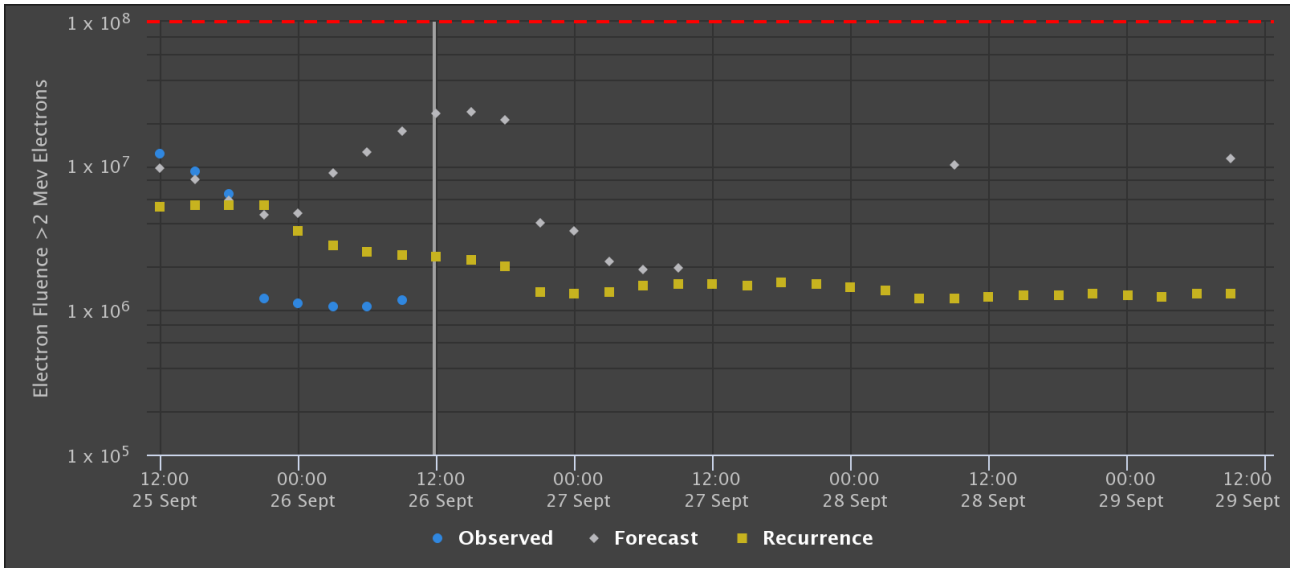
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed by GOES16 remains at mostly background levels following the arrival of the CME on the UTC evening of the 24 Sep. Further CME glancing blows may continue this trend, though confidence reduces later in the period with a slight chance or returning to high by Days 3 and 4 (28-29 Sep).

The associated 24 hour fluence is at background levels and is expected to remain below the Active threshold through the period. Any increasing trend by Day 4 (29 Sep) is low confidence. REFM is currently giving good overall guidance of the expected trend in the coming days, remaining below Active throughout.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: MOSWOC REFM output.



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